REVIEWS AND BOOK NOTICES.

THE PRINCIPLES OF SCIENCE.*—Though each scientist, whether consciously or not, does his work on principles underlying all useful and durable efforts, yet the methods have been gradually developed, and the laborer in one department may be ignorant of the mode of procedure in others quite remote from his line of study. The author discusses the methods common to all the sciences, though with a bias towards physical science, particularly physics, chemistry and astronomy. As a result we have a book which we are sure will win the sympathy of the reader, as it is an earnest and sensible treatise. Wherever we have opened the volume we have been attracted by the interest and clearness of the style, and the general tone of the discussion which, though on the whole conservative, is in full accordance with the spirit of modern science.

The chapters on the use of hypothesis, and the character of the experimentalist are capital. Professor Jevons boldly says "it is wholly a mistake to say that modern science is the result of the Baconian philosophy; it is the Newtonian philosophy and the Newtonian method which have led to all the great triumphs of physical science, and I repeat that the 'Principia' forms the true 'Novum Organum.'" If we mistake not, the theory of evolution, as suggested by Lamarck, Spencer, Darwin and others is a result of the Newtonian rather than the Baconian method; certainly it may be said in its present stage to be a "hypothetical anticipation of nature," valuable as it is as a means of research.

In the chapter on Classification the author states his belief that a natural classification is an "arrangement which would display the genealogical descent of every form from the original life germ. Those morphological resemblances upon which the classification of living beings is almost always based are inherited resemblances, and it is evident that descendants will usually resemble their parents and each other in a great many points." Much importance is given to the bifurcate or dichotomic arrangement so universally used in descriptive biology.

* The Principles of Science; a treatise on Logic and Scientific Method. By W. Stanley Jevons. Special American Edition, bound in one volume. New York. MacMillan & Co., 1874. 8vo. pp. 480.

How a mind trained in logic and the methods of exact science looks upon the theory of evolution, may be seen from the following extract:—

"The genealogical view of the mutual relations of animals and plants leads us to discard all notions of any regular progression of living forms, or any theory as to their symmetrical relations. It was at one time a great question whether the ultimate scheme of natural classification would prove to be in a simple line, or a circle, or a combination of circles. Macleay's once celebrated system was a circular one, and each class-circle was composed of five order-circles, each of which was composed again of five tribe-circles, and so on, the subdivision being at each step into five minor circles. Thus he held that in the animal kingdom there were five sub-kingdoms—the Vertebrata, Annulosa, Radiata, Acrita, and Mollusca. Each of these was again divided into five—the Vertebrata consisting of Mammalia, Reptilia, Pisces, Amphibia, and Aves.* It is quite evident that in any such symmetrical system the animals were made to suit themselves to the classes instead of the classes being suited to the animals.

We now perceive that the ultimate system will be an almost infinitely extended genealogical tree, which will be capable of representation by lines on a plane surface of sufficient extent. But there is not the least reason to suppose that this tree will have a symmetrical form. Some branches of it would be immensely developed compared with others. In some cases a form may have propagated itself almost from primeval times with little variation.

In other cases frequent differentiations will have occurred. Strictly speaking, this genealogical tree ought to represent the descent of each individual living form now existing or which has existed. It should be as personal and minute in its detail of relations, as the stemma of the kings of England. We must not assume that any two forms are absolutely and exactly alike, and in any case they are numerically distinct. Every parent then must be represented at the apex of a series of divergent lines, representing the generation of so many children. Any complete and perfect system of classification must regard individuals as the infimæ species. But as in the lower races of animals and plants the differences between individuals are usually very slight, and apparently unimportant, while the numbers of such individuals are immensely great, beyond all possibility of separate treatment, scientific men have always stopped at some convenient but arbitrary point, and have assumed that forms so closely resembling each other as to present no constant difference were all of one kind. They have, in short, fixed their attention entirely upon the main features of family difference. In the genealogical tree which

*Swainson, 'Treatise on the Geography and Classification of Animals,' 'Cabinet Cyclopædia,' p. 201.

they have been unconsciously aiming to construct, diverging lines meant races diverging in character, and the purpose of all efforts at so-called natural classification was to trace out the relationships between existing plants or animals. Now it is evident that hereditary descent may have in different cases produced very different results as regards the problem of classification. In some cases the differentiation of characters may have been very frequent, and specimens of all the characters produced may have been transmitted to the present time. A living form will then have, as it were, an almost infinite number of cousins of various degrees, and there will be an immense number of forms finely graduated in their resemblances. Exact and distinct classification will then be almost impossible, and the wisest course will be not to attempt arbitrarily to distinguish forms closely related in nature, but to allow that there exists transitional forms of every degree, to mark out if possible the extreme limits of the family relationship, and perhaps to select the most generalized form, or that which presents the greatest number of close resemblances to others of the family, as the *type* of the whole.

Mr. Darwin, in his most interesting work upon Orchids, points out that the tribe of Malaxeæ are distinguished from Epidendreæ by the absence of a caudicle to the pollinia, but as some of the Malaxeæ have a minute caudicle the division really breaks down in the most essential point.

'This is a misfortune,' he remarks,* 'which every naturalist encounters in attempting to classify a largely developed or so-called natural group, in which, relatively to other groups, there has been little extinction. In order that the naturalist may be enabled to give precise and clear definitions of his divisions, whole ranks of intermediate or gradational forms must have been utterly swept away: if here and there a member of the intermediate ranks has escaped annihilation, it puts an effectual bar to any absolutely distinct definition.'

In other cases a particular plant or animal may perhaps have transmitted its form from generation to generation almost unchanged, or, what comes to the same result, those forms which diverged in character from the parent stock, may have proved unsuitable to their circumstances, and may have perished sooner or later. We shall then find a particular form standing apart from all others, and marked by various distinct characters. Occasionally we may meet with specimens of a race which was formerly far more common but is now undergoing extinction, and is nearly the last of its kind. Thus we may explain the occurrence of exceptional forms such as are found in the Amphioxus. The Equisetaceæ perplex botanists by their want of affinity to other orders of Acrogenous plants. This doubtless indicates that their genea-

* Darwin, 'Fertilization of Orchids.' p. 159.

logical connexion with other plants must be sought for in the most distant past ages of geological development.

Constancy of character, as Mr. Darwin has said,* is what is chiefly valued and sought after by naturalists; that is to say naturalists wish to find some distinct family mark, or group of characters by which they may clearly recognize the relationship of descent between a large group of living forms. It is accordingly a great relief to the mind of the naturalist when he comes upon a definitely marked group, such as the Diatomaceæ, which are clearly separated from their nearest neighbours the Desmidiaceæ by their siliceous framework and the absence of chlorophyll. But we must no longer think that because we fail in detecting constancy of character the fault is in our classificatory sciences. Where gradation of character really exists, we must devote ourselves to defining and registering the degrees and limits of that gradation. The ultimate natural arrangement will often be devoid of strong lines of demarcation.

Let naturalists, too, form their systems of natural classification with all the care they can, yet it will certainly happen from time to time that new and exceptional forms of animals or vegetables will be discovered, and will require the modification of the system. A natural system is directed, as we have seen, to the discovery of empirical laws of correlation, but these laws being purely empirical will frequently be falsified by more extensive investigation. From time to time the notions of naturalists have been greatly widened, especially in the case of Australian animals and plants, by the discovery of unexpected combinations of organs, and such events must often happen in the future. If indeed the time shall come when all the forms of plants are discovered and accurately described, the science of Systematic Botany will then be placed in a new and more favourable position, as remarked by Alphonse Decandolle.†"

From paying too much attention to a classification by types, *i.e.*, by selecting one typical form and grouping around it allied forms, Professor Jevons believes that "a certain laxity of logical method is thus apt to creep in, the only remedy for which will be the frank recognition of the fact that according to the theory of hereditary descent, the gradation of characters is probably the rule, and the precise demarcation between groups the exception."

The author agrees with those naturalists who regard the existence of any such groups as genera and species as "an arbitrary creation of the naturalist's mind;" an important result of the establishment of the theory of evolution being "to explode all notions

*'Descent of Man,' vol. i, p. 214.

†'Laws of Botanical Nomenclature,' p. 16.

about the existence of natural groups constituting separate creations." The whole is in his opinion a question of degree.

What is the outcome of the tendencies of modern scientific thought, materialism and the reign of physical law? The logical and courageous philosopher with the modesty of true science will exclaim with our author, after a survey of the little that is positively known of the laws of nature that "before a rigorous logical scrutiny the Reign of Law will prove to be an unverified hypothesis, the Uniformity of Nature an ambiguous expression, the certainty of our scientific inferences to a great extent a delusion."

The closing paragraphs of the book leave an excellent impression, and its whole tendency is to induce that attitude of the mind which characterizes the true philosopher who, as our author quotes from Faraday, "should be a man willing to listen to every suggestion, but determined to judge for himself. He should not be biased by appearances; have no favourite hypothesis; be of no school: and in doctrine have no master. He should not be a respecter of persons, but of things. Truth should be his primary object. If to these qualities be added industry, he may indeed hope to walk within the veil of the temple of nature."

SCAMMON'S MARINE MAMMALS OF THE NORTHWESTERN COAST AND AMERICAN WHALE-FISHERY.*—The title of Capt. Scammon's important work indicates sufficiently its object and scope. It is divided into three parts, besides containing a lengthy appendix. Part I (comprising 112 pp.) is devoted to the natural history of the Cetacea, or the whales, porpoises and dolphins. Part II (69 pp.) treats in a similar way of the Pinnipedia, or the seals, while Part III (87 pp.) contains a concise and very interesting history of the American Whale-fishery. In Part I, the author has before him an almost wholly unworked field, and one in which he proves himself to have been an intelligent and faithful laborer. The marine mammals, and especially the Cetacea, from the nature of the element in which they live, as well as their generally unwieldy proportions and wary dispositions, are among the most difficult animals to study that the naturalist encounters. Only a

* The Marine Mammals of the Northwestern Coast of North America, described and illustrated: together with an account of the American Whale-fishery. By Charles M. Scammon, Captain U. S. Revenue Marine. San Francisco: John H. Carmany & Co. 1874. 4to, 319 pp., with 27 lithographic plates and numerous woodcuts.